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Long-term neurologic outcomes following paediatric out-of-hospital cardiac arrest☆

Erica Michiels[a,*], Linda Quan[b,c], Florence Dumas[d], Thomas Rea[b]

[a] Michigan State University, USA
[b] University of Washington, USA
[c] Seattle Children's Hospital, USA
[d] Paris Cardiovascular Research Center, Paris Descartes University, France

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ABSTRACT

Aim: Evaluate long-term neurologic outcome for paediatric survivors of OHCA.
Methods: Subjects <19 years who experienced OHCA from 1976–2007 and survived to hospital discharge were included. Demographics, neurologic outcomes and years of survival were determined using the King County Emergency Medical Service cardiac arrest database, Seattle Children's Hospital medical records, Washington State Death Database and National Death Index. A Paediatric Cerebral Performance Category (PCPC) score (1–6) was determined for the index hospitalization discharge and all subsequent visits.
Results: From 1976–2007, 1683 cases of OHCA resulted in 91 survivors to hospital discharge. 18/91 survivors identified had pre-morbid conditions. 72/91 survivors had follow-up PCPC scores. Patients were: ≤5 years (53%) and 54% female. 33/35 patients with initial favorable neurologic outcomes (PCPC 1–2) maintained favorable neurologic status in long-term follow-up. 14/37 patients with initial unfavorable neurologic outcomes (PCPC 3–5) remained unfavorable over long-term follow-up. Six unfavorable patients showed some improvement, three of whom achieved favorable PCPC scores at last evaluation. One unfavorable patient declined from PCPC 4 to PCPC 5. Twenty patients with an initial unfavorable neurologic outcome died in long-term follow-up.
Conclusions: In this cohort study of neurologic outcomes for paediatric OHCA survivors, a favorable initial PCPC score was highly associated with stable long-term neurological outcomes. Those with poor neurologic status at initial discharge were unlikely to improve and were at greatest risk to die in follow-up. Future studies should focus on improving neurologic outcomes and prospectively evaluating the long-term neurologic course.

Introduction

Paediatric out-of-hospital cardiac arrest (OHCA) victims have poor survival and potentially devastating neurologic consequences. Published data estimates approximately 50% of survivors will have substantial neurologic impairment at the time of hospital discharge[1,2] yet there is little information regarding the long-term expectations for neurologic recovery in this group of children.[3–5] A better understanding of the anticipated neurologic course for a paediatric survivor of OHCA would help inform families and physicians regarding short and long-term care decisions. Long-term prognosis also has implications for research and policy as medicine strives to use evidence to provide cost-conscious care. To help inform these issues, we evaluated the long-term neurologic outcome among a population-based cohort of patients aged <19 years who survived OHCA and were discharged alive from the hospital.

Methods

Study design, setting, and population

We conducted a retrospective cohort study of all persons <19 years who had an OHCA, were successfully resuscitated, and discharged alive from a hospital in King County, WA between January

Abbreviations: EMS, Emergency medical services; OHCA, out-of-hospital cardiac arrest; PCPC, paediatric cerebral performance category.

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* Correspondence to: Secchia Center, Department of Emergency Medicine, 15 Michigan St. NE, Grand Rapids, MI 49503, USA.
E-mail address: Erica.michiels@spectrumhealth.org (E. Michiels).

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1, 1976 and December 31, 2007. King County is comprised of urban, suburban and rural areas and is served by two-tiered emergency medical service (EMS) systems that generally followed the American Heart Association Guidelines for resuscitation throughout the years of the study.[6] The size of the population increased from 1.1 million in 1970 to 1.9 million in 2010.[7] The study was approved by the Seattle Children's Hospital, Public Health—Seattle & King County, and Washington State Institutional Review Boards.

Cohort identification and data collection

Subjects were identified from the King County and Seattle EMS cardiac arrest surveillance databases. These databases have prospectively collected information about each OHCA patient treated in Seattle and greater King County since 1976.[8,9] Patients were determined to have suffered OHCA if an EMS provided CPR and/or the patient was shocked with an AED (by a public access defibrillator) prior to EMS arrival. Patients <19 years of age who experienced an OHCA and survived to hospital discharge were eligible for this investigation. A uniform, study-specific data collection form was used to review EMS and hospital records. Hospital records were reviewed at Seattle Children's Hospital, a tertiary care children's hospital, and at Harborview Medical Center, a county hospital and level one trauma center. Information was collected regarding the Utstein characteristics, survival and neurological status at the initial hospital discharge and at each subsequent re-hospitalization or clinic visit.[10]

We reviewed hospital records to assess neurologic status at every hospital discharge or clinic visit using the Paediatric Cerebral Performance Category (PCPC) score. The PCPC score is a reliable and validated score created as an efficient way to quantify a child's cognitive function following a critical illness or injury.[11–13] The score ranges from 1 to 6 where 1 is normal, 2 is mild disability, 3 is moderate disability, 4 is severe disability, 5 is coma or vegetative state and 6 is brain death.[11,12] To determine the PCPC score, the admission history, physical exam and discharge summaries were reviewed. The scores were determined independently by three physicians who were blinded to the hospital discharge PCPC. All scores were reviewed by the primary investigator for agreement. On three occasions, there was inconsistency between investigators regarding the PCPC score, this was resolved by the primary investigator by re-reviewing the chart. In each occurrence, a patient in a persistent vegetative state had been assigned a PCPC of 6 and the score was corrected to a PCPC of 5.

Outcome measures

To identify subsequent deaths we linked patients to the National Death Index and the Washington State Death Database using identifiers such as name, date of birth, father's name and/or mother's maiden name. Patients identified in the National Death Index or Washington State Death Database were deemed non-survivors. Survival time was calculated from the date of hospital discharge until the date of death or until December 31, 2009 when the database was last searched. The PCPC score was calculated upon discharge from the initial hospitalization and at every subsequent re-hospitalization or visit to a Seattle Children's Hospital clinic until the end of the study period.

Statistical analysis

We used descriptive statistics to characterize demographic, clinical and field care features according to neurologic status defined as "favorable outcome" for PCPC scores of 1–2 and "unfavorable outcome" for PCPC scores of 3–5 initially determined at the time of the hospital discharge following the arrest. The subsequent change in PCPC score was assessed by comparing the PCPC score at initial hospital discharge with the last available follow-up PCPC score. We also assessed whether the time period of the arrest (1977–1986, 1987–1996 and 1997–2008) was associated with long-term neurologic outcome as resuscitation methods have changed throughout the decades.

Results

For the period 1976–2007, there were 1683 cases of EMS-treated paediatric OHCA in King County. Of those, 91 patients survived to hospital discharge for an overall survival of 5.4%. Survival following hospital discharge was 92% at 1 year, 86% at 5 years, and 77% at 20 years. Pre-existing comorbidities were present in 18/91 patients and were most often cardiac or neurologic in nature. Of the 91 patients who survived to hospital discharge, follow-up PCPC scores could be determined for 72 patients from the years of 1977–2008. The follow-up time from the initial PCPC score to the final PCPC score varied by patient with a median of 4.3 years (2.7–6).

In the cohort of 72 patients with follow-up PCPC scores, there were 20 deaths in 1449 person-years of follow-up (28%). All deaths occurred in those discharged home with unfavorable neurologic outcomes. Cause-of-death data were available for 18 of 20 subsequent deaths, and deaths were primarily due to anoxic brain damage (33%) and sequelae of accident (33%). Approximately half of the patients were female (54%) and ≤5 years (53%) (Table 1). Patients' year of arrest was evenly distributed throughout the years of the study period: 1977–1986 (29%), 1987–1996 (39%) and 1997–2008 (32%). The most common cause of arrest was respiratory (49%), 15/35 patients with a respiratory cause of arrest were drowning victims. The majority of patients had a witnessed arrest (76%), received bystander CPR (65%), received ≤2 doses of adrenaline (epinephrine) (80%), and achieved pre-hospital return of spontaneous circulation (ROSC) (97%). A shockable rhythm was present upon EMS arrival for 46% of patients. The initial PCPC score at hospital discharge was favorable (PCPC 1–2) for 48% of patients (Table 1). The demographics of the patients with follow-up PCPC scores were not statistically different from the 19 with missing PCPC scores (Table 2).

Table 1
Patient characteristics.

	Overall	Favorable neurologic outcome	Unfavorable neurologic outcome
	N = 72	*N* = 35	*N* = 37
Female gender	39 (54)	25 (64)	14 (36)
Age > 5	34 (47)	22 (59)	12 (34)
BystanderCPR	45 (65)	26 (76)	19 (54)
Witnessed	48 (76)	29 (87)	19 (63)
Shockable rhythm	31 (46)	17 (49)	14 (42)
Intubation	58 (84)	31 (89)	27 (79)
Adrenaline doses received, *n* (%)			
0 Doses	26 (39)	15 (46)	11 (33)
1–2 Doses	27 (41)	14 (42)	13 (40)
≥3 Doses	13 (20)	4 (12)	9 (27)
Pre-hospital ROSC, *n* (%)	66 (97)	32 (94)	34 (92)
Arrest diagnosis, *n* (%)			
Respiratory	35 (49)	18 (49)	17 (49)
Cardiac	20 (28)	14 (38)	6 (17)
Other	17 (23)	5 (13)	12 (34)
Year of arrest, *n* (%)			
1977–1986	21 (29)	8 (22)	13 (37)
1987–1996	28 (39)	14 (38)	14 (40)
1997–2008	23 (32)	15 (40)	8 (23)
Initial PCPC score at hospital discharge, *n* (%)			
1	21 (29)	20 (54)	1 (3)
2	14 (19)	13 (35)	1 (3)
3	4 (6)	1 (3)	3 (9)
4	20 (28)	3 (8)	17 (48)
5	13 (18)	0	13 (37)